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(71) Applicant *(for all designated States except US)*: **LG ELECTRONICS INC.** [KR/KR]; 20, Yoido-Dong, Youngdungpo-Gu, Seoul 150-010 (KR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **JUN, Young-Hoan** [KR/KR]; Daedong Apt. 109-102, Sangnam-Dong, Changwon, Gyeongsangnam-Do 641-777 (KR). **SHIN, Dong-Hee** [KR/KR]; Jugong Apt. 201-1401, Danggam 4-Dong, Busanjin-Gu, Busan 614-766 (KR). **BAE, Gyoo-Jong** [KR/KR]; 175-7, Bonggok-Dong, Changwon, Gyeongsangnam-Do 641-823 (KR). **LEE, Woo-Geun** [KR/KR]; 304-29, Deokcheon 2-Dong, Buk-Gu, Busan 616-816 (KR).

(74) Agent: **PARK, Jang-Won**; Jewoo Bldg., 5th Floor, 200, Nonhyun-Dong, Gangnam-Gu, Seoul 135-010 (KR).

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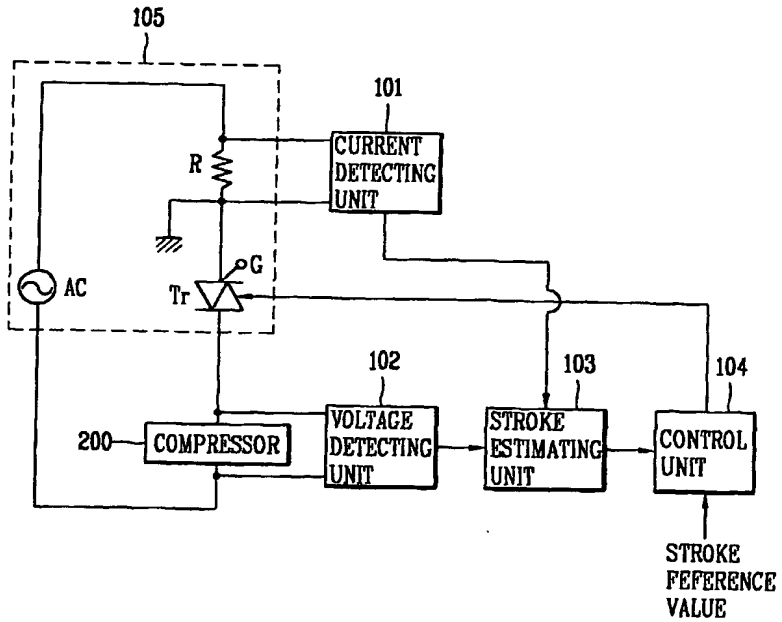
[Continued on next page]

(54) Title: OPERATION CONTROL APPARATUS FOR COMPRESSOR AND METHOD THEREOF



(57) Abstract: In an operation control apparatus and a method thereof, the compressor can be protected from overloading through a current control device instead of an OLP (Over Load Protector) and a PTC thermistor (Positive Temperature Coefficient thermistor). The operation control apparatus includes: a stroke estimated unit for estimating a stroke of the compressor on the basis of a current and a voltage applied to an interior motor of the compressor and a motor constant of the interior motor; a control unit for generating a control signal for varying a stroke of the compressor on the basis of the estimated stroke value and a preset stroke reference value; and a current control means being turned on/off so as to vary a stroke voltage applied to the interior motor of the compressor.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

OPERATION CONTROL APPARATUS FOR COMPRESSOR AND METHOD THEREOF

TECHNICAL FIELD

The present invention relates to a compressor and, particularly to an operation control apparatus for a compressor used for a refrigerator and a method thereof.

BACKGROUND ART

Generally, in a compressor, particularly a reciprocating compressor, compression efficiency is higher than a general compressor since there is no crankshaft for converting a rotational movement into a linear movement and thus a friction loss is small.

In case that the reciprocating compressor is used for a refrigerator or an air conditioner, as varying a stroke voltage applied to the reciprocating compressor (interior motor of the compressor), being able to vary a compression ratio, so that freezing capacity can be controlled. The operation controlling apparatus for the reciprocating compressor will now be described with reference to Figure 1.

Figure 1 is a block diagram showing a configuration of the operation control apparatus for the reciprocating compressor according to a conventional art.

As shown therein, the reciprocating compressor according to the conventional art includes an OLP (Over Load Protector) 11 electrically

connected to a common terminal of a reciprocating compressor 12 and cutting off power applied to the interior motor (not shown) of the compressor 12 when a temperature of the compressor 12 is high or an overcurrent flows into the interior motor of the compressor 12; and a PTC thermistor (Positive Temperature Coefficient thermistor) 13 electrically connected to a sub-coil (not shown) of the compressor 12 and initially protecting the compressor from being over-loaded by cutting off a current applied to the compressor 12 when a temperature of the compressor 12 increases at an initial stage of driving.

Herein, the OLP 11 is electrically connected with the compressor 12, and cuts off power applied to the interior motor of the compressor 12 when a temperature of the compressor 12 is high or an overcurrent flows into the interior motor of the compressor. In addition, if an overload is generated at the compressor 12 due to a rapid increase of a temperature generated when the compressor 12 starts initially, the PTC thermistor cuts off a current applied to the interior motor of the compressor so as to protect the compressor 12 from being over-loaded when the compressor 12 initially starts.

However, in the reciprocating compressor used for a refrigerator according to the conventional art, a stroke increases slowly so that an over current is not generated rapidly when the compressor initially starts. Accordingly, the PTC thermistor 13 is not required to be installed at the compressor, and a cost for producing the compressor increases since the PTC thermistor 13 is installed at the compressor 12.

In addition, since the OLP 11 is installed at the compressor 12

according to the conventional art, the operation control apparatus can not be miniaturized by the size of a current device (not shown) in the OLP 11. Also, a production cost of the compressor 12 increases by installing the OLP 11 at the compressor 12.

DISCLOSURE OF THE INVENTION

Therefore, it is an object of the present invention to provide an operation control apparatus for a compressor and its method capable of protecting the compressor from being over-loaded through a current control device instead of a PTC thermistor and an OLP.

It is another object of the present invention to provide an operation control apparatus for a compressor and its method capable of reducing a production cost of the compressor by protecting the compressor from being over-loaded through a current control device instead of a PTC thermistor and an OLP.

To achieve the above objects, there is provided an operation control apparatus for a compressor including: a stroke estimating unit for estimating a stroke of the compressor on the basis of a current and a voltage applied to an interior motor of the compressor and a motor constant of the interior motor; a control unit for generating a control signal for varying a stroke of the compressor on the basis of the estimated stroke value and a stroke reference value; and a current control means for varying a stroke voltage applied to the interior motor of the compressor by being turned on/off according to the control signal.

To achieve the above objects, there is also provided an operation control apparatus for a compressor including: a detecting means for detecting a current and a voltage applied to the compressor; a storing means presetting a standard current value for preventing an overcurrent generated when the compressor initially starts, and storing the set standard current value; a comparing means for comparing the detected current value and the standard current value, and outputting a comparing signal corresponding to the comparing result; and a control means for cutting off a current applied to the compressor by turning off the current control means installed at the compressor by the comparing signal, or controlling a stroke voltage applied to the compressor by turning on/off the current control means at a certain period.

To achieve the above objects, there is also provided a method for controlling an operation of a compressor including the steps of: detecting a current and a voltage applied to the compressor; estimating a stroke of the compressor on the basis of the detected values of a current and a voltage and a motor constant of an interior motor of the compressor; and increasing a voltage applied to the compressor by lengthening an on/off period of the current control means installed at the compressor when the estimated stroke value is smaller than a preset stroke reference value, and decreasing a voltage applied to the compressor by shortening the on/off period of the current control means when the estimated stroke value is greater than the stroke reference value.

To achieve the above objects, there is provided a method for

controlling an operation of a compressor including the steps of: detecting a current applied to the compressor; comparing the detected current value and a preset standard current value; cutting off a current applied to the compressor by turning off a current control means installed at the compressor when the detected current value is greater than the standard current value; and, when the detected current value is the same as or smaller than the standard current value, estimating a stroke of the compressor, and controlling a stroke voltage applied to the compressor by turning on/off the current control means at a certain period on the basis of the estimated value and a preset stroke reference value.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram showing a configuration of an operation control apparatus for a reciprocating compressor according to the conventional art;

Figure 2 is a block diagram showing a configuration of an operation control apparatus for a reciprocating compressor according to a first embodiment of the present invention;

Figure 3 is a flow chart showing an operation order of an operation control apparatus for a reciprocating compressor according to a first embodiment of the present invention;

Figure 4 is a block diagram showing a configuration of an operation control apparatus for a reciprocating compressor according to a second embodiment of the present invention; and

Figure 5 is a flow chart showing an operation order of an operation control apparatus for a reciprocating compressor according to a second embodiment of the present invention.

MODES FOR CARRYING OUT THE PREFERRED EMBODIMENTS

Hereinafter, a preferred embodiment of an operation control apparatus for a compressor and its method capable of preventing damage to a compressor, which is caused by the overload (overcurrent), by using a current control device without using the OLP and the PTC thermistor, will now be described with reference to Figures 2 to 5. Herein, the compressor is installed at a refrigerator.

Figure 2 is a block diagram showing a configuration of the operation control apparatus for the reciprocating compressor according to a first embodiment of the present invention. That is, the amount of currents applied to the compressor 200 is controlled through the current control device (triac, Tr) installed at the compressor 200 without using the OLP (Over Load Protector) and the PTC thermistor. Also, when the compressor initially starts, a stroke of the compressor is estimated to slowly increase the stroke of the compressor, and varies the stroke of the compressor by turning on/off the current control device (Tr) at a certain period on the basis of the estimated stroke.

As shown therein, the operation control apparatus for the reciprocating compressor includes: a voltage detecting unit 102 for detecting a voltage applied to an interior motor (not shown) of the reciprocating compressor 200

when the reciprocating compressor is operated; a current detecting unit 101 for detecting a current applied to the interior motor of the compressor when the compressor 200 is operated; a stroke estimating unit 103 for estimating a stroke of the compressor on the basis of a voltage value detected from the voltage detecting unit 102, a current value detected from the current detecting unit 101 and a motor constant of the interior motor of the compressor; a control unit 104 for comparing the estimated stroke value and a preset stroke reference value, and generating a control signal on the basis of the comparing result; and a power supply unit 105 for on-off controlling an interior current control device (e.g. Triac, Tr) according to the control signal generated from the control unit 104 and thus varying a stroke voltage supplied to the interior motor of the reciprocating compressor 200. Herein, a resistor (R) in the power supply unit 105 is installed to measure a current applied to the compressor 200. In addition, the reciprocating compressor 200 varies an inner stroke by receiving a stroke voltage provided to the interior motor according to the stroke reference value set by a user, and vertically moves a piston (not shown) in the compressor.

Hereinafter, an operation of the operation control apparatus for the reciprocating compressor according to the first embodiment of the present invention will now be described in detail with reference to Figure 3.

First, the reciprocating compressor 200 varies the stroke by receiving a voltage supplied to the interior motor in depending on the stroke reference value set by a user, and thus vertically moves the piston. Herein, the stroke means a moving distance of the piston in the reciprocating compressor 200

while the piston reciprocally moves.

A turn-on period of the current control device of the power supply unit 105 is lengthened by a control signal outputted from the control unit 104. An alternating current power is supplied to the reciprocating compressor 200 due to the lengthened turn-on period, and thus the reciprocating compressor 200 is driven. At this time the voltage detecting unit 102 and the current detecting unit 101 detect a voltage and a current applied to the reciprocating compressor 200 respectively, and then output the detected value of the voltage and the current to the stroke estimating unit 103 (S11).

The stroke estimating unit 103 estimates a stroke of the compressor 200 on the basis of the voltage value detected from the voltage detecting unit 102, the current value detected from the current detecting unit 101 and a motor constant of the interior motor, and outputs the estimated stroke value to the control unit 104 (S12).

The control unit 104 compares the estimated stroke value and the preset stroke reference value, and outputs a control signal on the basis of the comparing result (S13). That is, when the estimated stroke value is smaller than the stroke reference value, the control unit 104 outputs a control signal for lengthening the turn-on period of the Tr to the Tr of the power supply unit 104 and thus increases a stroke voltage supplied to the reciprocating compressor 200. On the other hand, when the estimated stroke value is greater than the stroke reference value, the control unit 104 outputs a control signal for shortening the turn-on period of the Tr to the Tr of the power supply unit 105 and thus decreases a stroke voltage supplied to the reciprocating

compressor 200 (S14, S15).

Herein, the current control device (Tr) is installed instead of an OLP, and is on/off switched by the control signal of the control unit 104 so as to be able to vary a stroke of the compressor 200, or cut off a current applied to the interior motor of the compressor. In addition, preferably, one of a triac, GTP transistor (gate turn-off transistor or a gate turn-off thyristor), an IGBT (Insulated Gate bipolar Transistor) a bipolar transistor and a relay is used as the current control device.

Hereinafter, a configuration of an operation control apparatus for the reciprocating compressor according to a second embodiment of the present invention will now be described in detail with reference to Figure 4.

Figure 4 is a block diagram showing the configuration of the operation control apparatus for the reciprocating compressor according to the second embodiment of the present invention. That is, in the operation control apparatus for the reciprocating compressor according to the second embodiment of the present invention, a current control device (Tr) instead of the OLP and the PTC thermistor is installed at the compressor 200, and the amount of currents applied to the interior motor of the compressor 200 is controlled through the current control device (Tr). Also, in the operation control apparatus for the reciprocating compressor according to the second embodiment of the present invention, in order to protect the compressor 200 from an overcurrent generated when the compressor 200 initially starts, a current applied to the compressor 200 and a preset standard current is compared. Then, according to the comparing result, a current applied to the

interior motor of the compressor 200 is cut off by turning off the current control device (Tr) or a stroke of the compressor is controlled by turning on/off the current control device (Tr) at a certain period.

As shown in Figure 4, the operation control apparatus for the reciprocating compressor according to the second embodiment of the present invention includes: a voltage detecting unit 102 for detecting a voltage applied to an interior motor (not shown) of the reciprocating compressor when the reciprocating compressor 200 is operated; a current detecting unit 101 for detecting a current applied to the interior motor of the compressor 200 when the compressor 200 is operated; a stroke estimating unit 103 for estimating a stroke of the compressor on the basis of a voltage value detected from the voltage detecting unit 102, a current value detected from the current detecting unit 101 and a motor constant of the interior motor of the compressor; a standard current value storing unit 106 for storing a preset standard current value to cut off an overcurrent generated when the compressor initially starts; a comparing unit 107 for comparing the current value detected from the current detecting unit 101 and the standard current value previously stored at the standard current value storing unit 106, and outputting a comparing signal corresponding to the comparing result; a control unit 104 for generating a cut-off signal for cutting off a current applied to the interior motor of the compressor on the basis of the comparing signal, or comparing the estimated stroke value and the stroke reference value, and then generating a control signal on the basis of the comparing result; and a power supply unit 105 for cutting off a current applied to the interior motor of the compressor 200 by

turning off the inner current control device by the cut-off signal generated from the control unit 104, or controlling a stroke voltage applied to the interior motor of the reciprocating compressor 200 by on-off controlling the current control device (Tr) on the basis of the control signal.

Herein, when the current value detected from the current detecting unit 101 is greater than the standard current value previously stored at the standard current value storing unit 106, the control unit 104 generates a cut-off signal and outputs the generated cut-off signal to the current control device (Tr) in the power supply unit 105. At this time, the current control device (Tr) is turned off based on the cut-off signal so as to cut off a current applied to the interior motor of the compressor.

On the other hand, when the current value detected from the current detecting unit 101 is the same as or smaller than the standard current value previously stored at the standard current value storing unit 106, the control unit 104 generates a control signal and outputs the generated control signal to the current control device (Tr) in the power supply unit 105. That is, when the current value detected from the current detecting unit is the same as or smaller than the standard current value previously stored at the standard current value storing unit 106, the control unit 104 controls the turn-on period of the Tr in the power supply unit 105 and thus varies a stroke voltage applied to the interior motor of the compressor 200.

Hereinafter, an operation of the operation control apparatus for the reciprocating compressor according to a second embodiment of the present invention will now be described in detail with reference to Figure 5.

Figure 5 is a flow chart showing an operation order of an operation control apparatus for a reciprocating compressor according to the second embodiment of the present invention.

First, when the compressor 200 is operated, the current detecting unit 101 detects a current applied to the interior motor of the compressor 200 at a real time, and outputs the detected current value to the stroke estimating unit 103 and the comparing unit 107. At this time, when the compressor 200 is operated, the voltage detecting unit 102 detects a voltage applied to the interior motor of the compressor 200 at a real time, and outputs the detected voltage value to the stroke estimating unit 103 (S21).

The stroke estimating unit 103 estimates a stroke of the compressor 200 on the basis of the detected voltage value, the detected current value and the motor constant of the interior motor, and outputs the estimated value (the estimated stroke value) to the control unit 104.

The comparing unit 107 compares the standard current value previously stored at the standard current value storing unit 106 and the current value detected from the current detecting unit 101, and outputs a signal corresponding to the comparing result to the control unit 104.

When the current value detected from the current detecting unit 101 is greater than the standard current value, the control unit 104 generates a cut-off signal, and outputs the generated cut-off signal to the current control device (Tr) (S22). At this time, the current control device (Tr) is turned off based on the cut-off signal so as to cut off a current applied to the interior motor of the compressor (S23, S24).

On the other hand, when the current value detected from the current detecting unit 102 is the same as or smaller than the standard current value, the control unit 104 generates a control signal, and outputs the generated control signal to the current control device. That is, when the current value detected from the current detecting unit 102 is the same as or smaller than the stand current value, and the estimated stroke value is smaller than the stroke reference value, the control unit 104 outputs a control signal for lengthening a turn-on period of the Tr to the Tr and thus increases a stroke voltage supplied to the interior motor of the reciprocating compressor 200. On the other hand, when the current value detected from the current detecting unit 102 is the same as or smaller than the stand current value, and the estimated stroke value is greater than the stroke reference value, the control unit 104 outputs a control signal for shortening the turn-on period of the Tr to the Tr and thus decreases the stroke voltage supplied to the interior motor of the reciprocating compressor 200. That is, a stroke of the compressor 200 is varied by increasing or decreasing the stroke voltage (S25~S27).

Herein, the standard current value is preset by a user, and means a current value, which should be applied to the motor so that the interior motor of the compressor 200 is normally operated. That is, the standard current value is set by previously measuring a current value applied to the interior motor of the compressor when the compressor is normally operated, and then storing the measured value.

Accordingly, in the present invention, a damage of the compressor 200, which is caused by an overload (overcurrent), can be prevented without the

OLP and the PTC thermistor, and the compressor 200 can be controlled closely.

As so far described, in the present invention, a damage of a compressor, which is caused by the overcurrent, can be prevented by cutting off power applied to the interior motor of the compressor when a compressor is operated, or by applying power to the interior motor of the compressor, without using the OLP and the PTC thermistor.

Also, in the present invention, since the conventional OLP and the PTC thermistor is not used, but the operation control apparatus for controlling a stroke of the compressor is used, the stroke can be controlling closely, and a production cost of the compressor can be reduced.

Also, in the present invention, a compressor can be miniaturized by controlling an operation of the compressor through the current control device without using the conventional OLP and the PTC thermistor.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

CLAIMS

1. An operation control apparatus for a compressor comprising:

a stroke estimating unit for estimating a stroke of the compressor on the basis of a current and a voltage applied to an interior motor of the compressor and a motor constant of the interior motor;

a control unit for generating a control signal for varying a stroke of the compressor on the basis of the estimated stroke value and a preset stroke reference value; and

a current control means for varying a stroke voltage applied to the interior motor of the compressor in accordance with the control signal.

2, The apparatus of claim 1, wherein an OLP (Over Load Protector) and/or a PTC thermistor (Positive Temperature Coefficient thermistor) are not used for the operation control apparatus.

3. The apparatus of claim 1, wherein the control unit outputs the control signal for increasing the stroke voltage applied to the compressor when the compressor is initially driven, to the current control means.

4. The apparatus for claim 1, wherein, when the estimated stroke value is smaller than the stroke reference value, the control unit increases a voltage applied to the compressor by lengthening an on/off period of the current control means, and, when the estimated stroke value is greater than

the stroke reference value, the control unit decreases a voltage applied to the compressor by shortening the on/off period of the current control means.

5. An operation control apparatus for a compressor comprising:

detecting means for detecting a current and a voltage which are applied to a compressor;

a storing means for presetting a standard current value for preventing an overcurrent generated when the compressor initially starts, and storing the set standard current value;

a comparing means for comparing the detected current value and the standard current value, and outputting a comparing signal corresponding to the comparing result; and

a control means for cutting off a current applied to the compressor by turning off a current control means installed at the compressor by the comparing result, or for controlling a stroke voltage applied to the compressor by turning on/off the current control means at a certain period.

6. The apparatus of claim 5, wherein the current control means is one of a triac, a GTO transistor (gate turn-off transistor), an IGBT (Insulated Gate bipolar Transistor), a bipolar transistor and a relay.

7. The apparatus of claim 5, wherein the compressor is installed at a refrigerator.

8. The apparatus of claim 5, wherein the control means cuts off a current applied to the compressor by turning off the current control means when the detected current value is greater than the standard current value; and compares the stroke value estimated based on the detected voltage value, the detected current value and a motor constant of an interior motor of the compressor with the preset stroke reference value, and then varies a stroke of the compressor on the basis of the comparing result when the detected current value is smaller than the standard current value.

9. The apparatus of claim 5, wherein an OLP (Over Load Protector) and/or a PTC thermistor (Positive Temperature Coefficient thermistor) are not used for the operation control apparatus.

10. A method for controlling an operation of a compressor comprising the steps of;

detecting a current and a voltage applied to the compressor;

estimating a stroke of the compressor on the basis of the detected values of the current and the voltage and a motor constant of an interior motor of the compressor;

when the estimated stroke value is smaller than a preset stroke reference value, increasing a voltage applied to the compressor by lengthening an on/off period of a current control means installed at the compressor, and when the estimated stroke value is greater than a preset stroke reference value, decreasing a voltage applied to the compressor by

shortening the on/off period of the current control means.

11. A method for controlling an operation of a compressor comprising:

detecting a current applied to the compressor;

comparing the detected current value and a preset standard current value;

cutting off a current applied to the compressor by turning off a current control means installed at the compressor when the detected current value is greater than the standard current value; and

when the detected current value is the same as or smaller than the standard current value, estimating a stroke of the compressor, and controlling a stroke voltage applied to the compressor by turning on/off the current control means at a certain period on the basis of the estimated value and the preset stroke standard current value.

FIG. 1

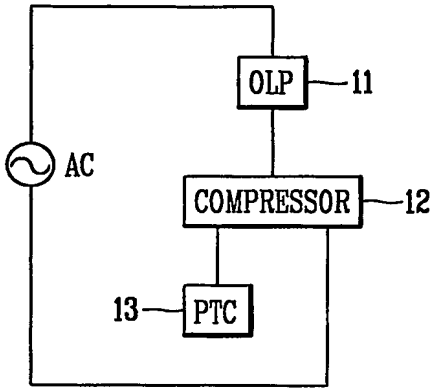

OLP
11
AC
COMPRESSOR
12
13
PTC

FIG. 2

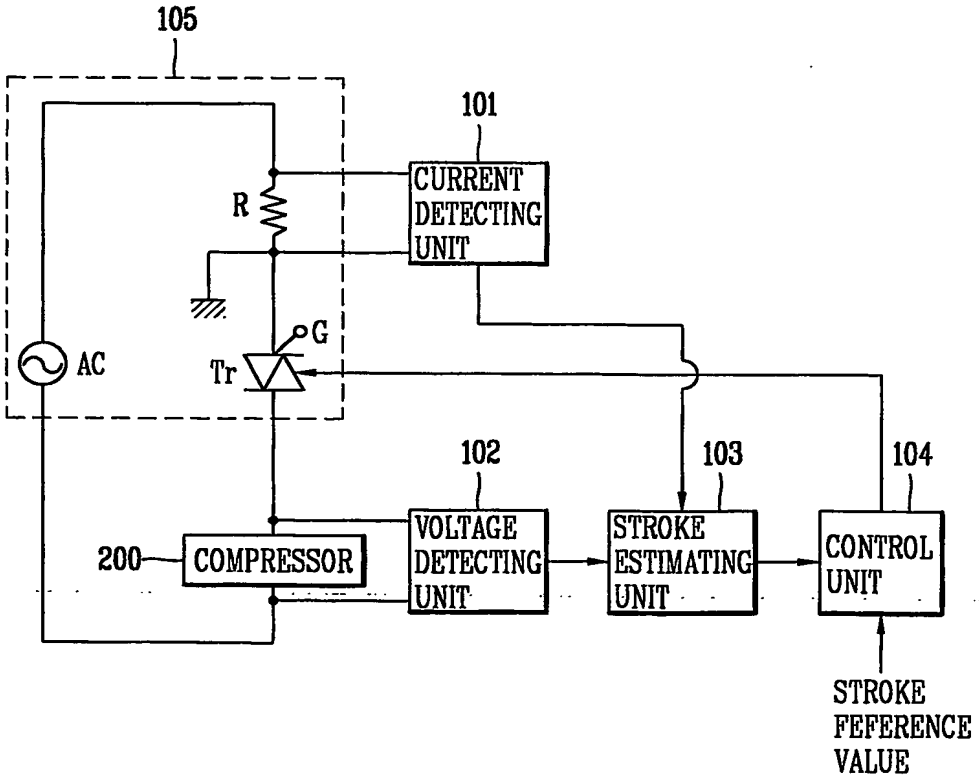

105
101
CURRENT DETECTING UNIT
R
G
AC
Tr
102
103
104
200
COMPRESSOR
VOLTAGE DETECTING UNIT
STROKE ESTIMATING UNIT
CONTROL UNIT
STROKE FEFERENCE VALUE

FIG. 3

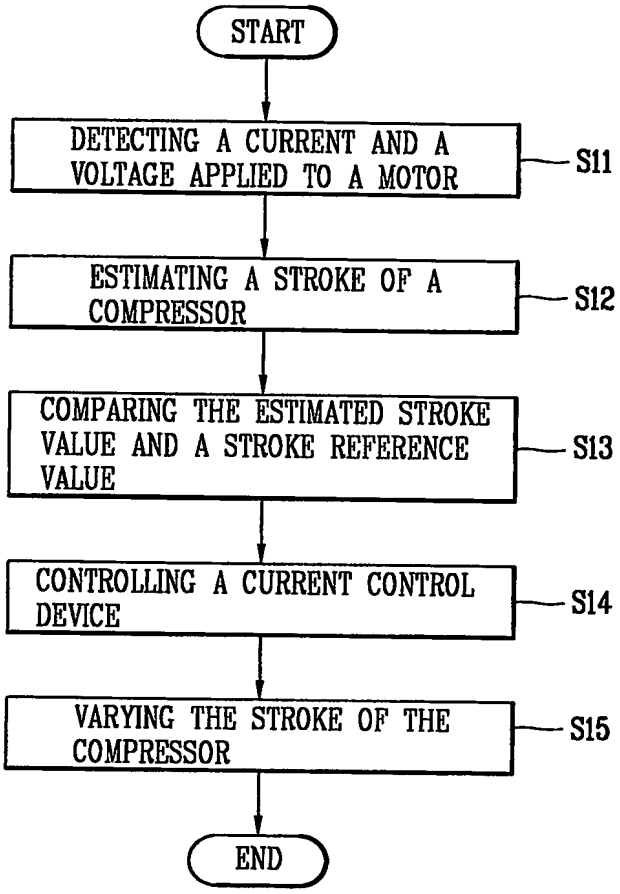

START
DETECTING A CURRENT AND A VOLTAGE APPLIED TO A MOTOR
S11
ESTIMATING A STROKE OF A COMPRESSOR
S12
COMPARING THE ESTIMATED STROKE VALUE AND A STROKE REFERENCE VALUE
S13
CONTROLLING A CURRENT CONTROL DEVICE
S14
VARYING THE STROKE OF THE COMPRESSOR
S15
END

FIG. 4

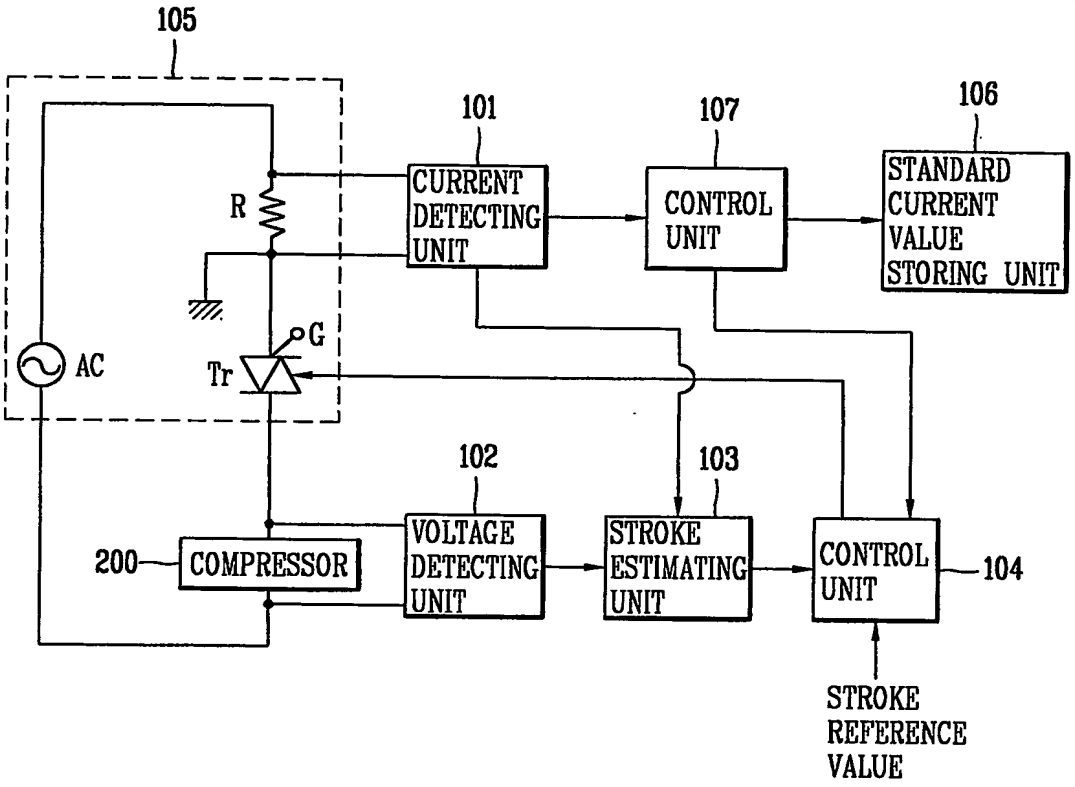
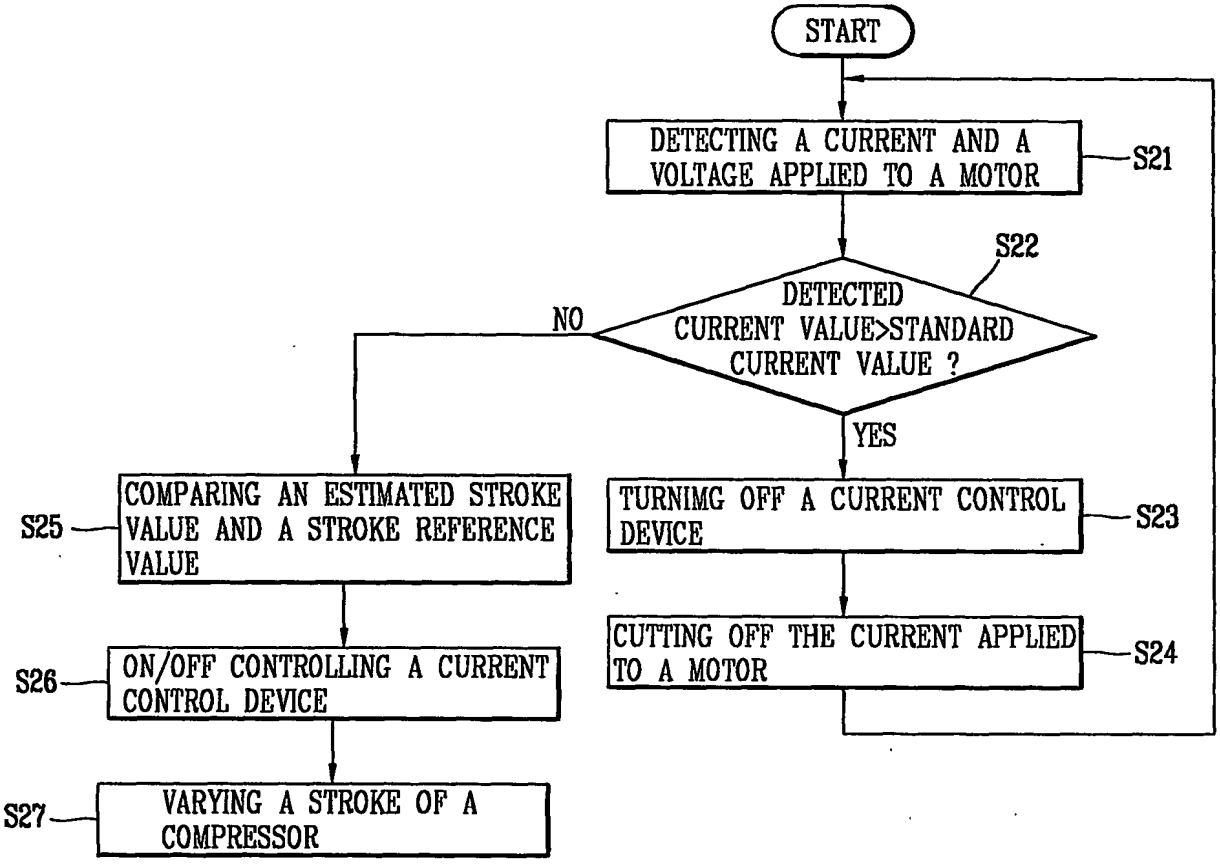

105
101
107
106
CURRENT DETECTING UNIT
CONTROL UNIT
STANDARD CURRENT VALUE STORING UNIT
R
G
AC
Tr
102
103
200
COMPRESSOR
VOLTAGE DETECTING UNIT
STROKE ESTIMATING UNIT
CONTROL UNIT
104
STROKE REFERENCE VALUE

FIG. 5


START
DETECTING A CURRENT AND A VOLTAGE APPLIED TO A MOTOR
S21
S22
DETECTED CURRENT VALUE>STANDARD CURRENT VALUE ?
NO
YES
TURNIMG OFF A CURRENT CONTROL DEVICE
S23
CUTTING OFF THE CURRENT APPLIED TO A MOTOR
S24
COMPARING AN ESTIMATED STROKE VALUE AND A STROKE REFERENCE VALUE
S25
ON/OFF CONTROLLING A CURRENT CONTROL DEVICE
S26
VARYING A STROKE OF A COMPRESSOR
S27

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2003/002045

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 F25D 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25D, F04C, F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KR, JP as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS "compressor", " [voltage/current]control", "Overload", " thermister" etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,073,457 A (Hans Kampf, Karl Lochmahr) JUN/13/2000 See figures, abstracts etc.	1 ~ 11
A	US 5,479,785 A (Robert M. Novak) Jan/02/1996 See figures, abstracts etc.	1 ~ 11
A	US 4,809,516 A (Richard D. Jones) Mar/07/1989 See figures, abstracts etc.	1 ~ 11
A	JP 09-113087 A (MORISHITA KENICHI , ODA MASATAKA) May/02/1997 See entire documents	1 ~ 11
A	JP 13-251888 A (CHIN BIEN-YOBU) Sep/14/ 2001 See entire documents	1 ~ 11
A	JP 04-055676 A (KOYAMA TAKAMOTO) Feb/24/1992 See entire documents	1 ~ 11

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	SONG, Seung Hoon Telephone No. 82-42-481-5513

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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